The GOES-R Proving Ground: Plans for 2011 and Beyond

Presented by Jim Gurka

NOAA/NESDIS/GOES-R Program Office

Jan. 26, 2011

AMS Annual Meeting, Seattle WA

Contributors

Steven Goodman
NOAA/NESDIS/GOES-R Program Office, Greenbelt, MD 20771

Timothy Schmit
NOAA/NESDIS/Center for Satellite Applications and Research, Madison, WI

Mark DeMaria and Daniel Lindsey
NOAA/NESDIS/Center for Satellite Applications and Research, Fort Collins, CO

Bonnie Reed
General Dynamics Information Technology

Geoffrey Stano and Richard Blakeslee
NASA/MSFC Short-term Prediction Research and Transition (SPoRT) Center, Huntsville, AL

Russell Schneider and Chris Siewert
Cooperative Institute for Mesoscale Meteorological Studies, NOAA/NWS/Storm Prediction Center, Norman, OK

Donald Macgorman and Kristin Kuhlman
NOAA/ Office of Atmospheric Research/ NSSL

Wayne Feltz
Cooperative Institute for Meteorological Satellite Studies (CIMSS)

Gary Hufford
NWS Alaska Region Scientific Services Division

Outline

- What is the GOES-R Proving Ground?
- Examples of GOES-R Proxy Products tested at:
  - Cooperative Institutes
  - SPC Spring Experiment
  - NHC 2010 Hurricane Season
  - Aviation Testbed at AWC and Alaska
- Lessons Learned and User Input
- Plans for 2011
- Summary

GOES-R Proving Ground

– What is the GOES-R Proving Ground?

- Collaborative effort between the GOES-R Program Office, selected NOAA/ NASA Cooperative Institutes, NWS forecast offices, NCEP National Centers, JCSDA, and NOAA Testbeds.

- Where proxy and simulated GOES-R products are tested, evaluated and integrated into operations before the GOES-R launch

- A key element of GOES-R User Readiness (Risk Mitigation)

Proving Ground Mission Statement

The GOES-R Proving Ground engages NWS in pre-operational demonstrations of selected capabilities of next generation GOES

- Objective is to bridge the gap between research and operations by:
  - Utilizing current systems (satellite, terrestrial, or model/synthetic) to emulate future GOES-R capabilities
  - Infusing GOES-R products and techniques into NWS operations with emphasis on AWIPS and transitioning to AWIPS-II.
  - Engaging in a dialogue to provide feedback to developers from users

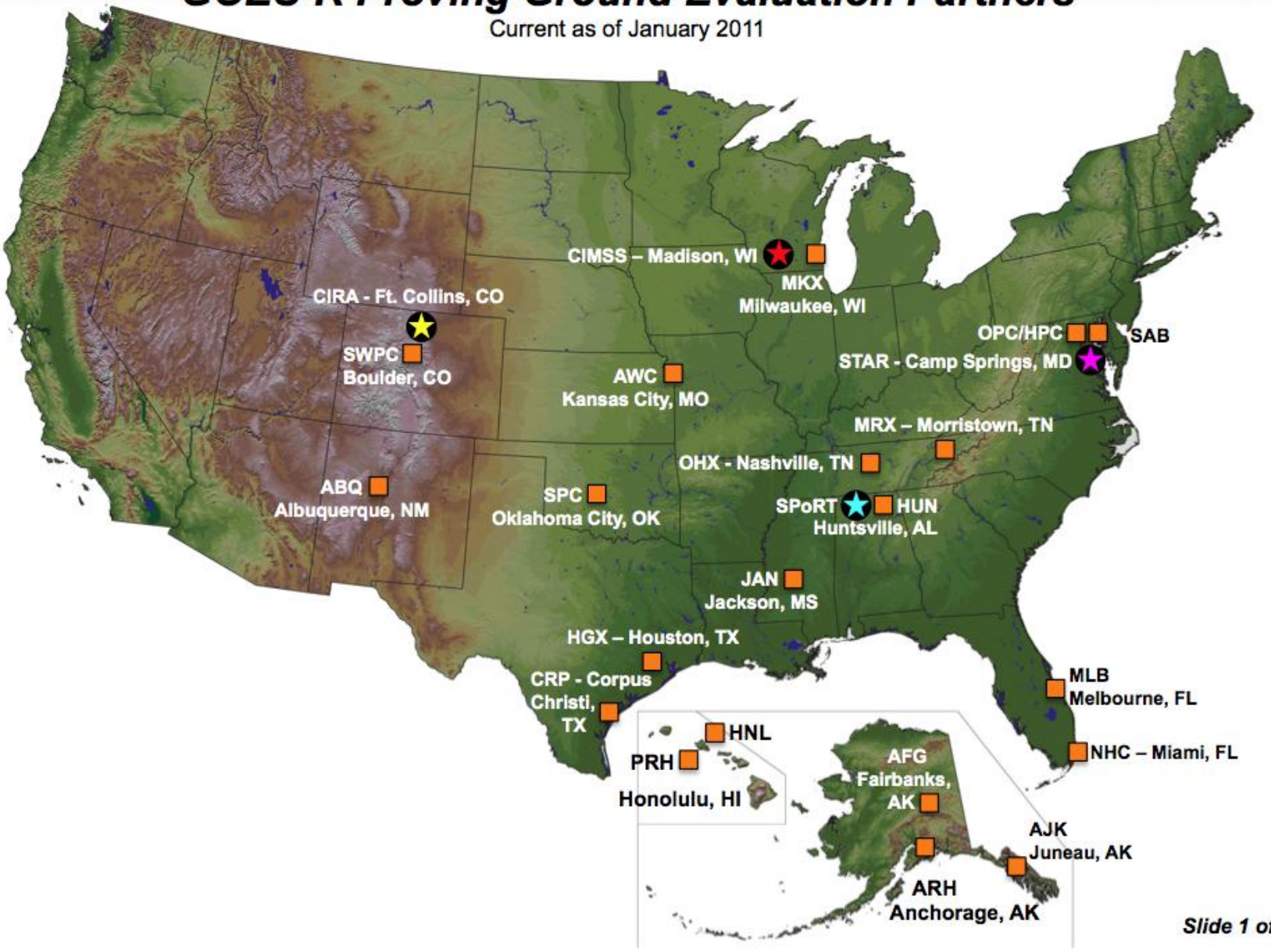
- The Proving Ground accomplishes its mission through:
  - Sustained interaction between developers and end users for training, product evaluation, and solicitation of user feedback.
  - Close coordination with GOES-R Algorithm Working Group (AWG) and Risk Reduction programs as sources of demonstration products, promoting a smooth transition to operations

Intended outcomes are Day-1 readiness and maximum utilization for both the developers and users of GOES-R products, and an effective transition to operations

GOES-R Proving Ground Partners

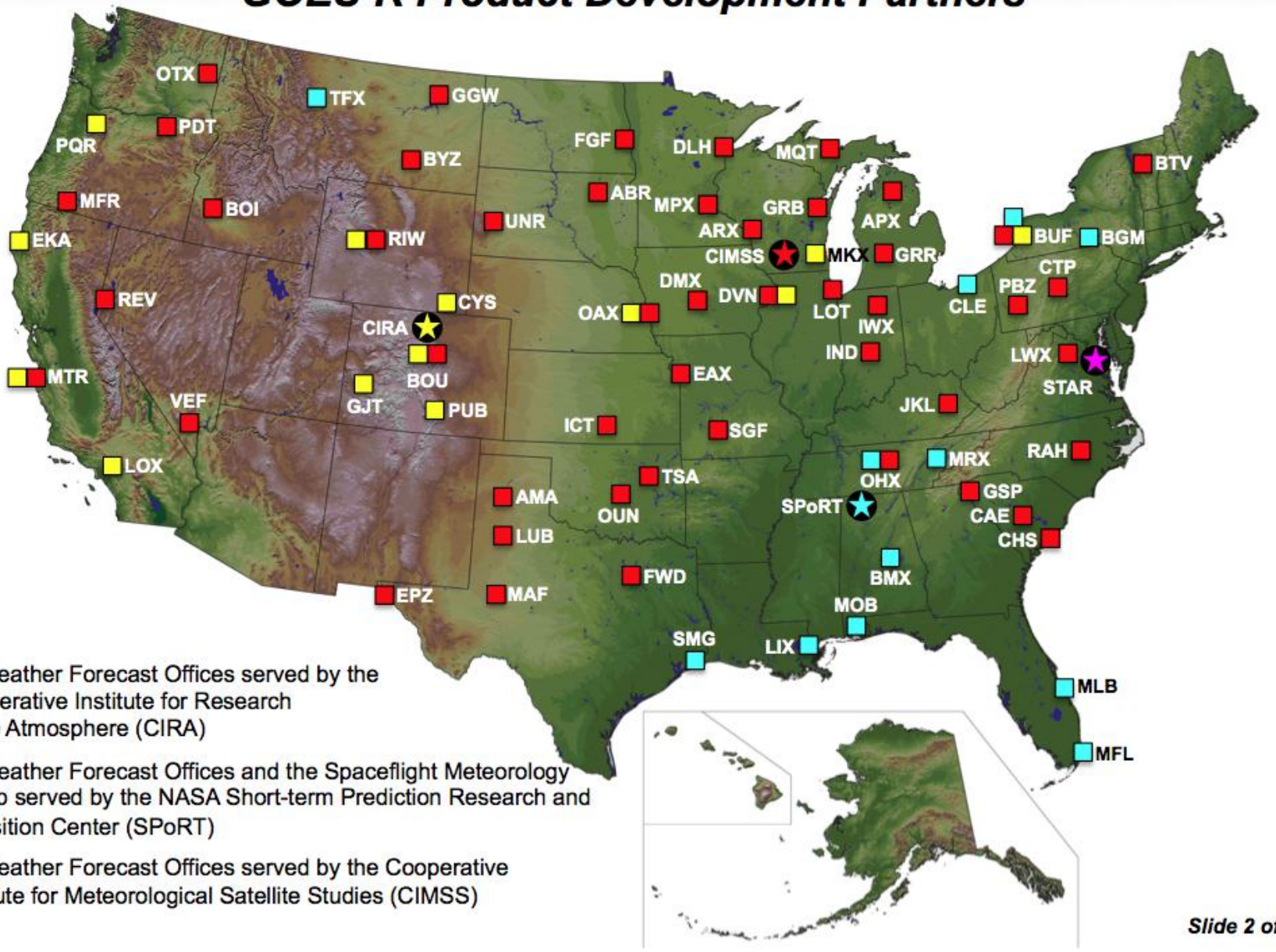
GOES-R Proving Ground Evaluation Partners

Current as of January 2011



GOES-R Proving Ground Partners

GOES-R Product Development Partners



- ***13*** Weather Forecast Offices served by the Cooperative Institute for Research in the Atmosphere (CIRA)
- ***12*** Weather Forecast Offices and the Spaceflight Meteorology Group served by the NASA Short-term Prediction Research and Transition Center (SPoRT)
- ***48*** Weather Forecast Offices served by the Cooperative Institute for Meteorological Satellite Studies (CIMSS)

GOES-R Warning Product Set

The following list of products offers opportunity for near-real time Warning Related utility.

Baseline Products:
Volcanic Ash: detection & Height
Cloud and Moisture Imagery
Hurricane Intensity
Lightning Detection: Events, Groups & Flashes
Rainfall Rate / QPE
Total Precipitable Water
Fire/Hot Spot Characterization

Option 2 Products:
Aircraft Icing Threat
Convective Initiation
Enhanced “V” / Overshooting Top Detection
Low Cloud and Fog
SO_2 Detection

SPC Spring Experiment

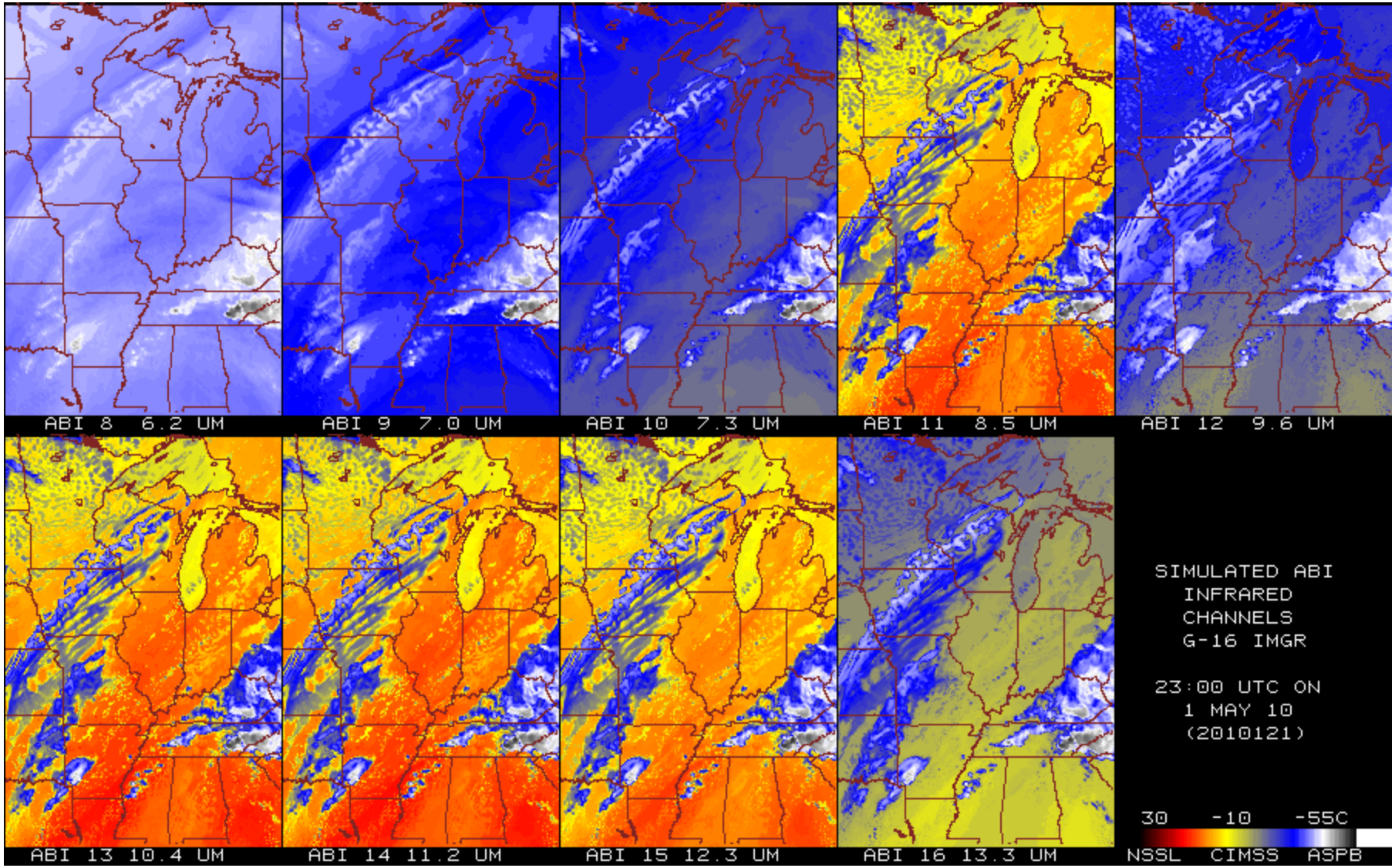
- In 2009 experiment…primary focus was on Convective Initiation Product.
- In 2009 experiment…LMA data used to generate 10-km source density product from three sites:
  - Norman OK
  - Huntsville AL
  - Washington D.C.

SPC Spring Experiment

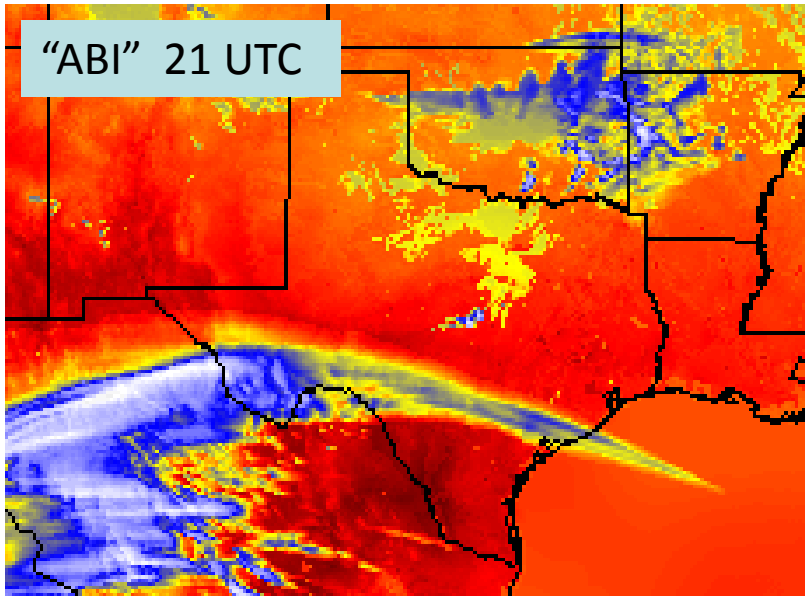
- In 2010 experiment…Products evaluated include:
  - Convective Initiation (CI)
  - Lightning Detection
  - Enhanced V/ Overshooting Top Detection
  - Cloud and Moisture Imagery
  - Simulated lightning threat
  - Hail Probability (risk reduction)
- In 2010…. Creation of a pseudo-GLM product
  - Total flash extent density product at 8 km resolution
  - More accurate simulation of future GLM products
  - Data from additional sites provided to support SPC

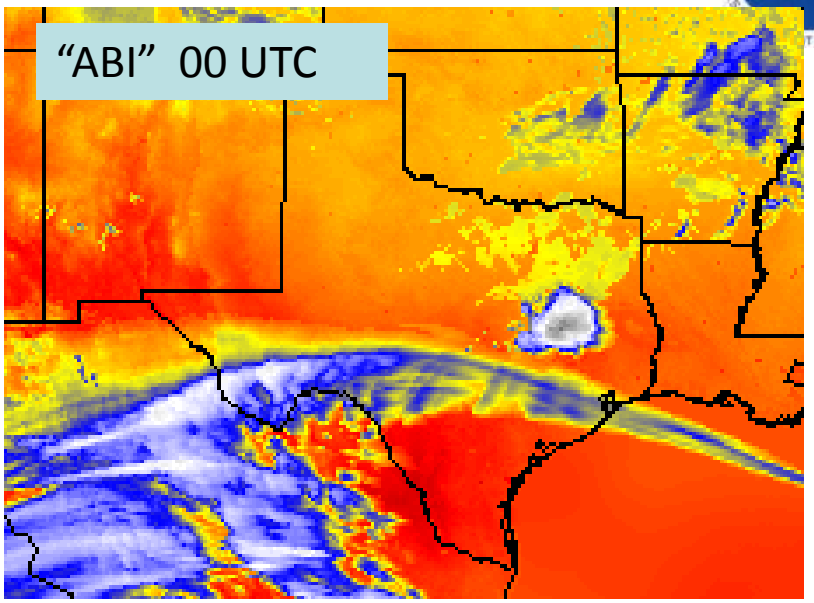
Estimated ABI Emitted-only bands

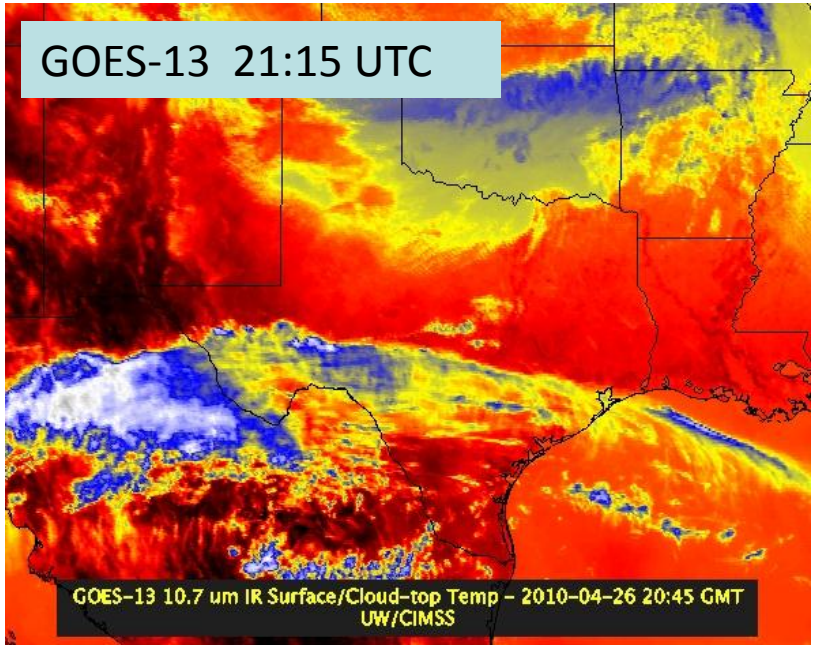
From NSSL WRF

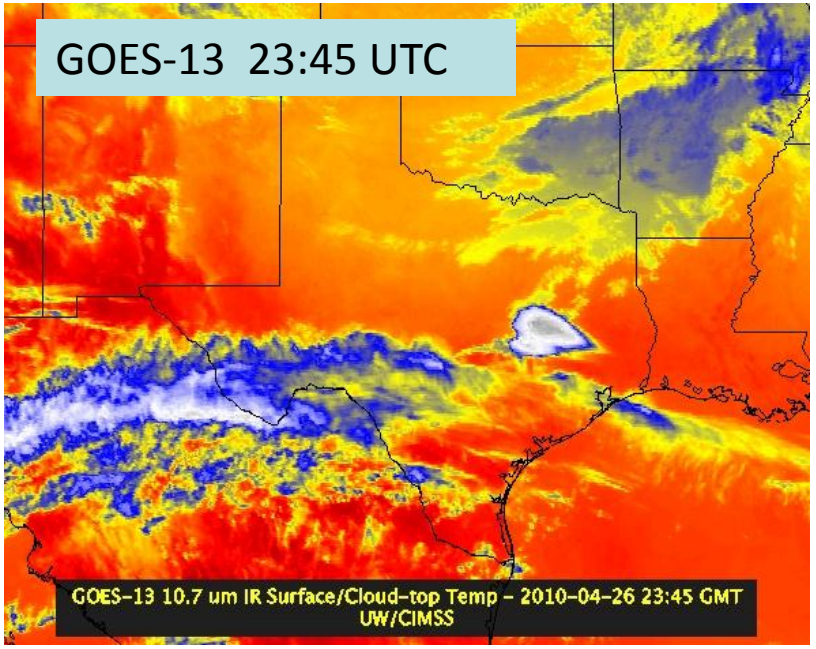


NSSL WRF and GOES Imager

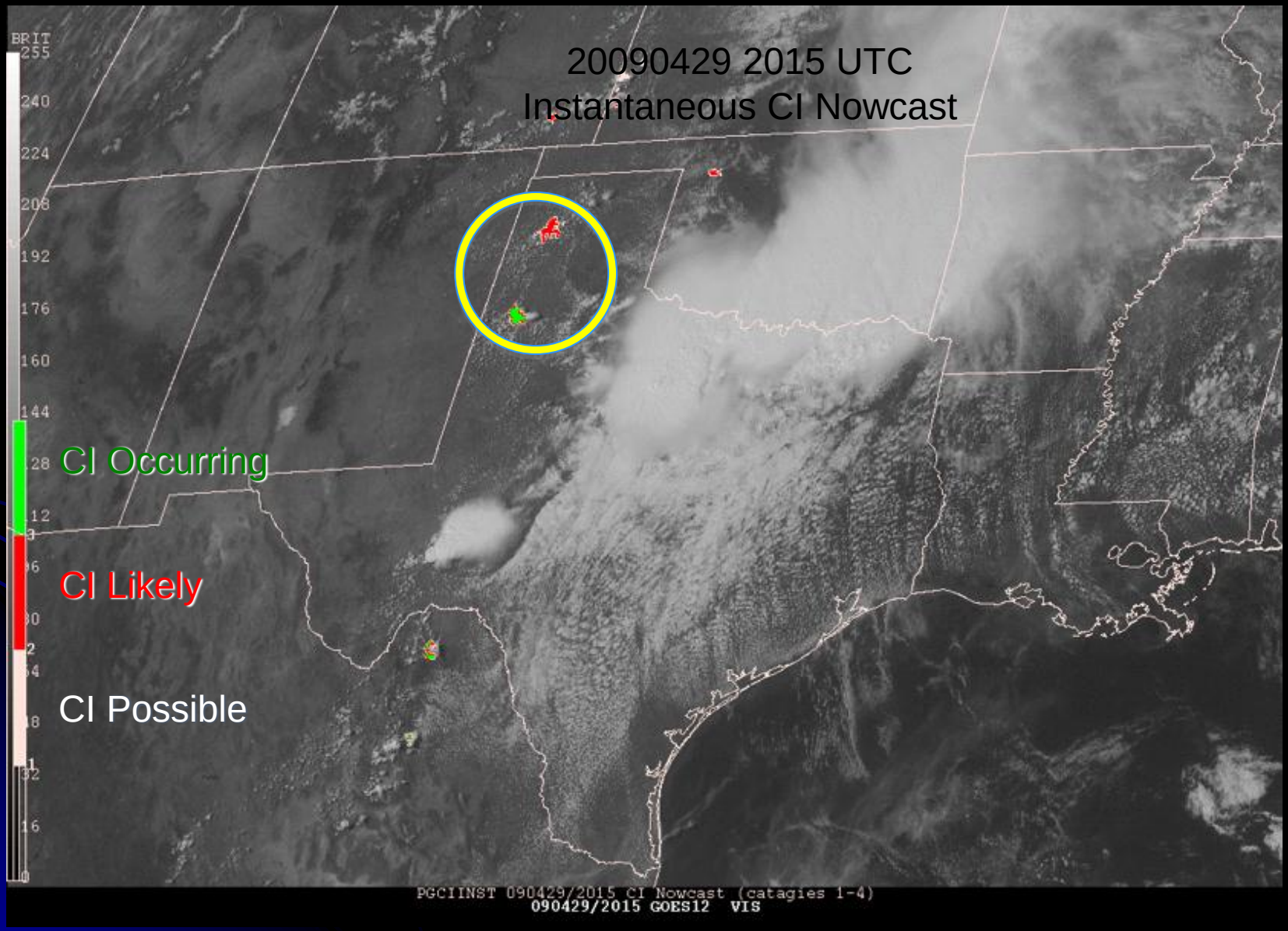


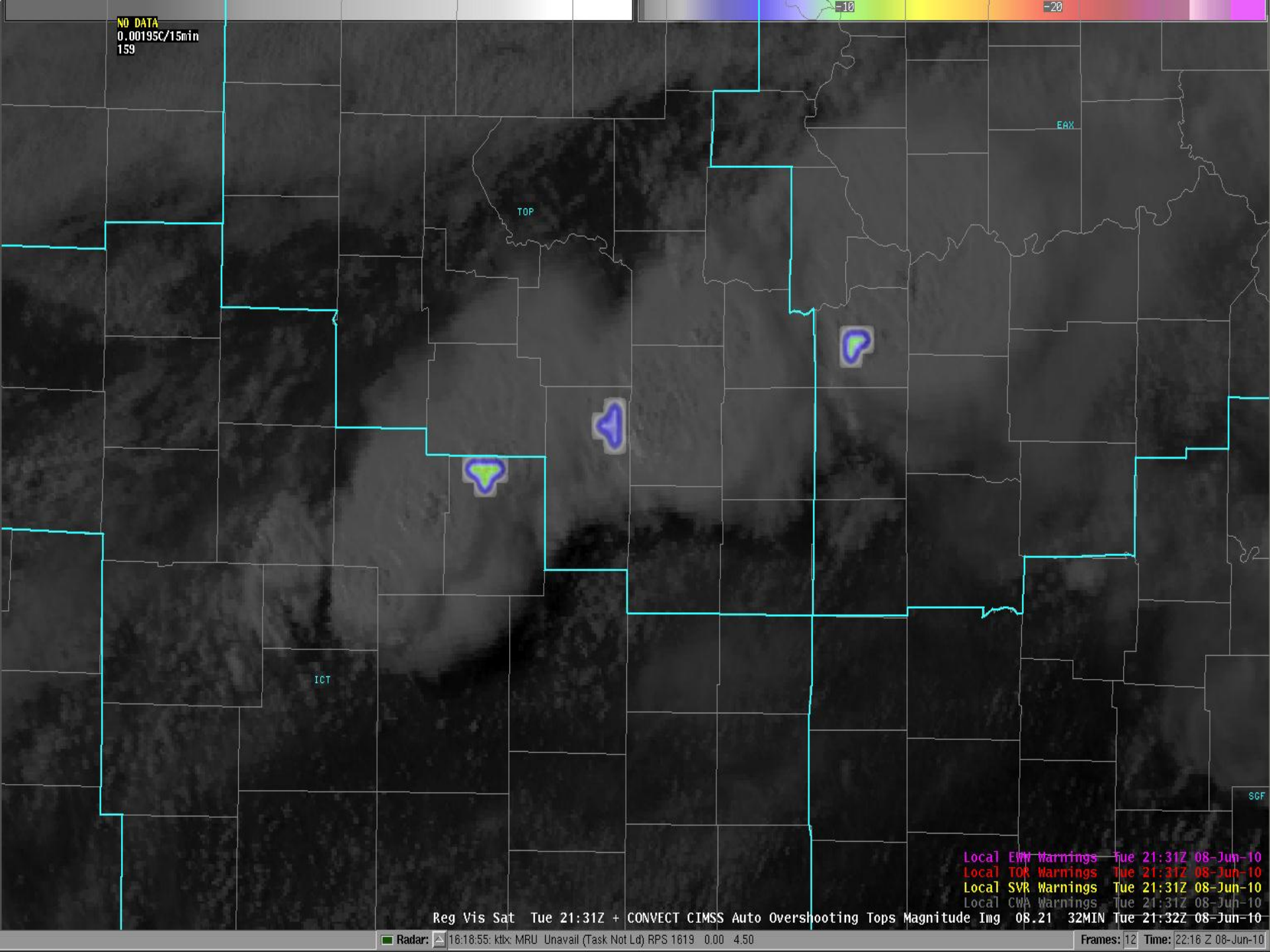






20090429 Dryline CI Case
SPC HWT Proving Ground




NO DATA
0.00195C/15min
159
-10
-20
EAX
TOP
ICT
SGF
Local EWW Warnings Tue 21:31Z 08-Jun-10
Local TOR Warnings Tue 21:31Z 08-Jun-10
Local SVR Warnings Tue 21:31Z 08-Jun-10
Local CWA Warnings Tue 21:31Z 08-Jun-10
Reg Vis Sat Tue 21:31Z + CONVECT CIMSS Auto Overshooting Tops Magnitude Img 08.21 32MIN Tue 21:32Z 08-Jun-10
Radar: 16:18:55: ktlx: MRU Unavail (Task Not Ld) RPS 1619 0.00 4.50
Frames: 12 Time: 22:16 Z 08-Jun-10

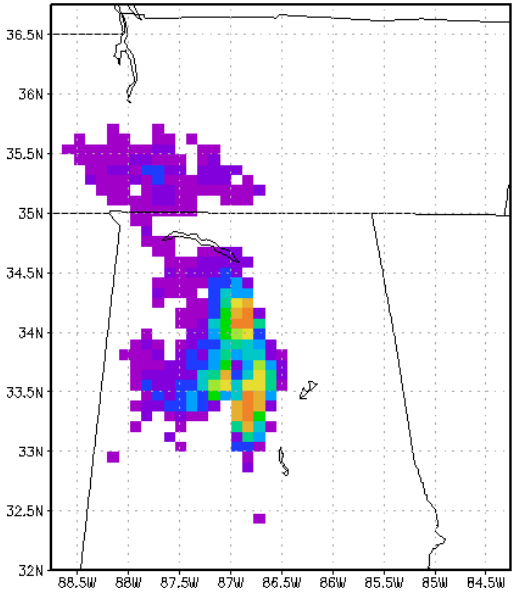
SPoRT Pseudo GLM Product

Provide forecaster exposure to GLM data, differences from LMA, applicability to severe weather forecasting – benefits transition of full AWG proxy when available

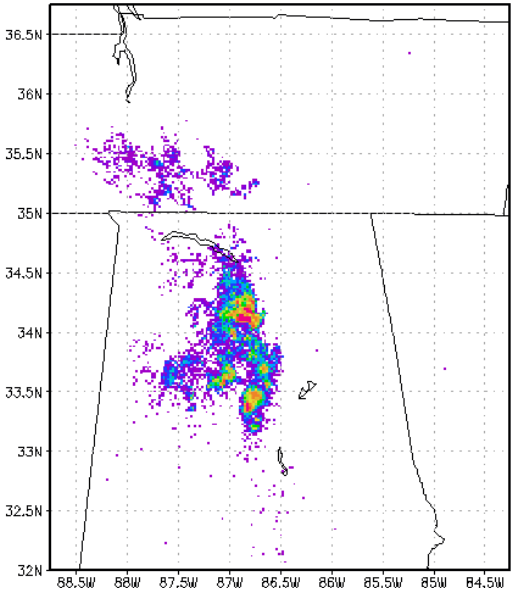
Flash Extent Density derived from LMA data at GLM resolution

- different from AWG proxy - no optical data
- forecaster demonstration and education
- applicable to other total lightning networks
- focus on AWIPS II development with user feedback

Pseudo GLM Flash Extent



LMA Source Densities



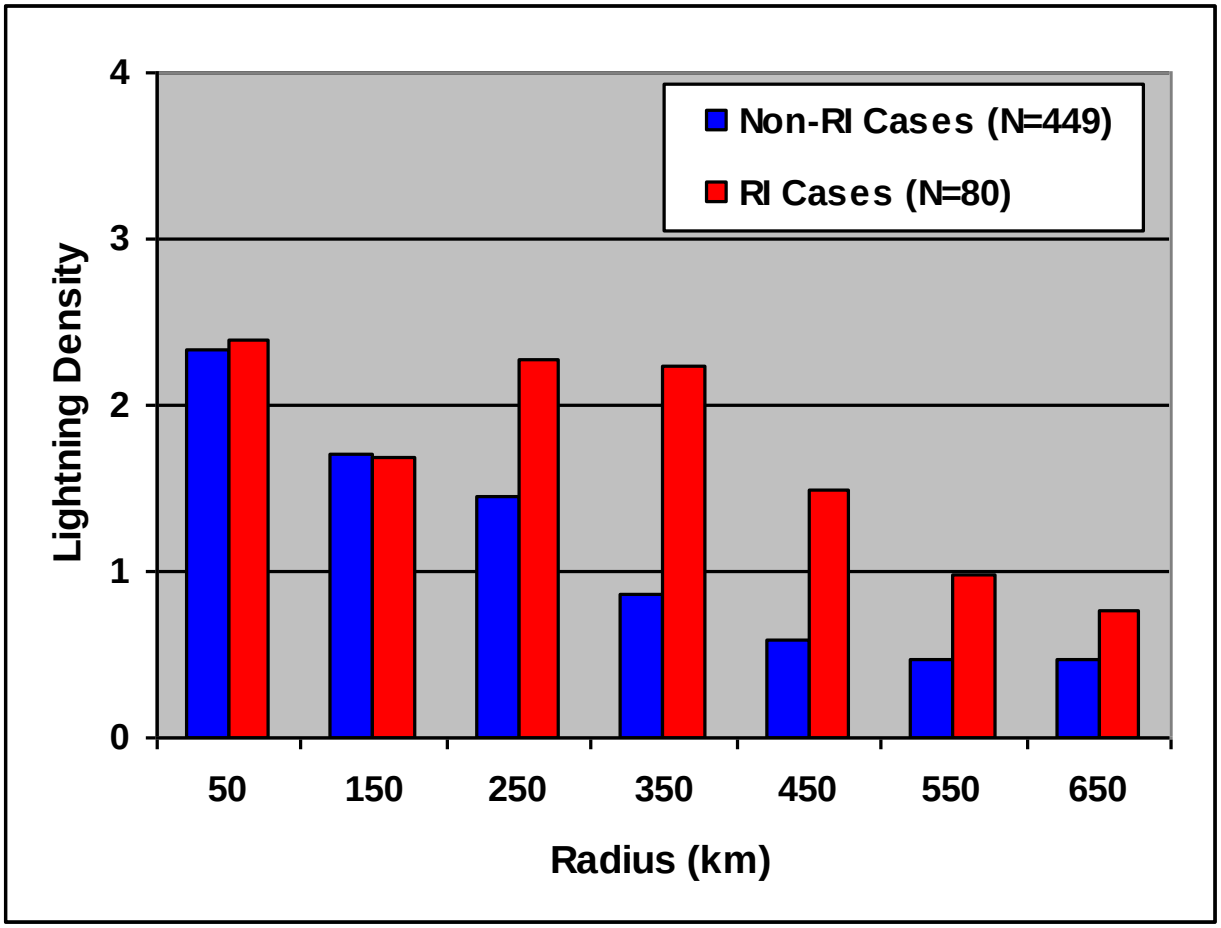
NHC Proving Ground

- Hurricane products for 2010 PG:
  - Hurricane intensity estimate (baseline)
  - Super rapid scan imagery (baseline)
  - RGB aerosol/ dust product
  - Saharan air layer (SAL)
  - Rapid intensification index
    - Based on global ground-based lightning detection network

2010 NHC Proving Ground

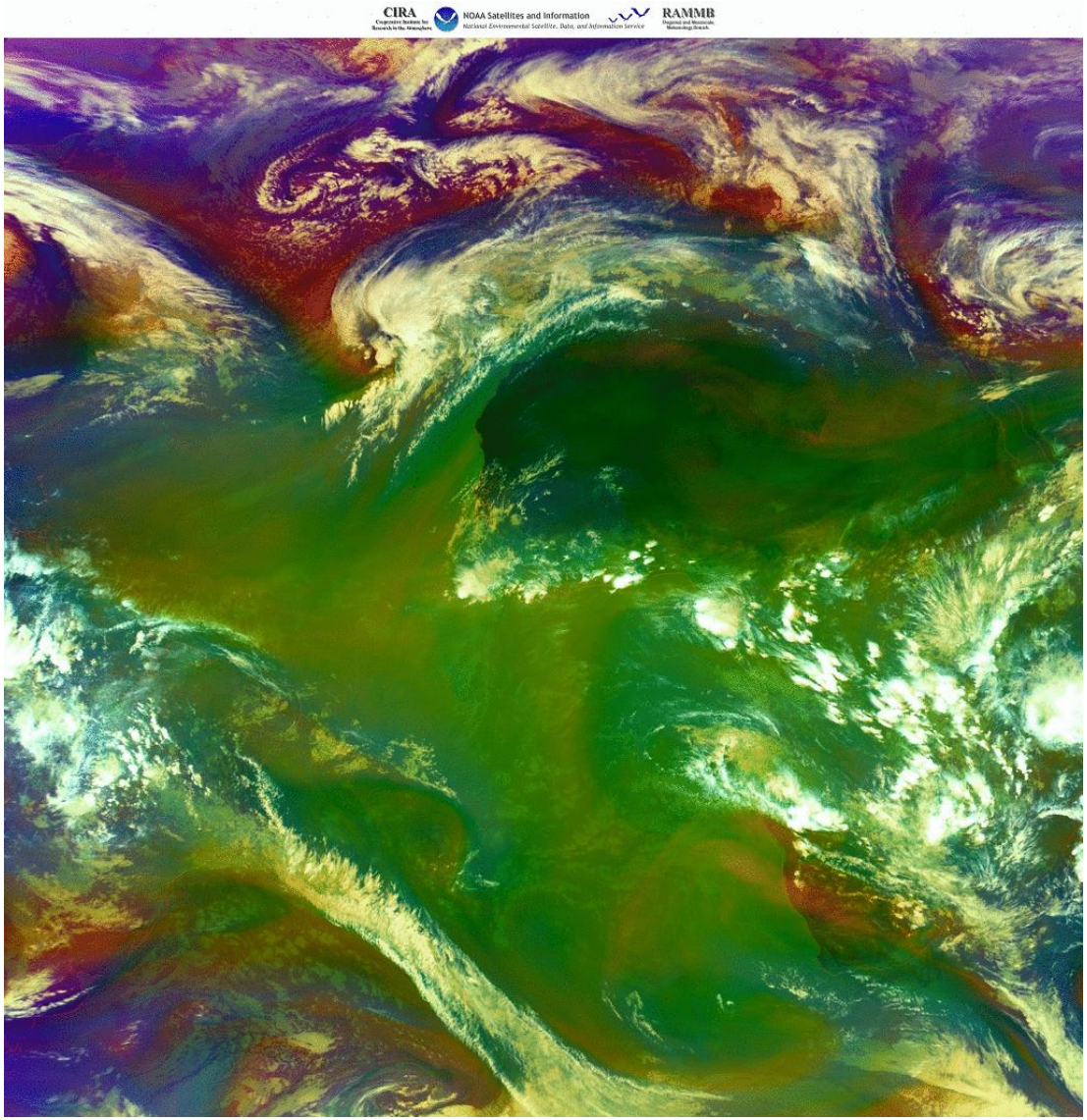
- Ground-based WWLLN data used as a proxy for GLM in tropical cyclone studies
  - Adjustment to account for the low detection rate of WWLLN and conversion of C-G to total lightning using OTD/LIS climatology
- Storm-centered lightning density calculated and related to changes in tropical cyclone intensity
  - Lightning density in the rain bands is related to subsequent intensity changes (if vertical shear accounted for)
- Algorithm used lightning data in combination with global model fields to predict rapid intensity change
- Tested in real time in 2010 using Vaisala GLD-360 data

Comparison of Lightning Density for Intensifying and non-Rapidly intensifying cases

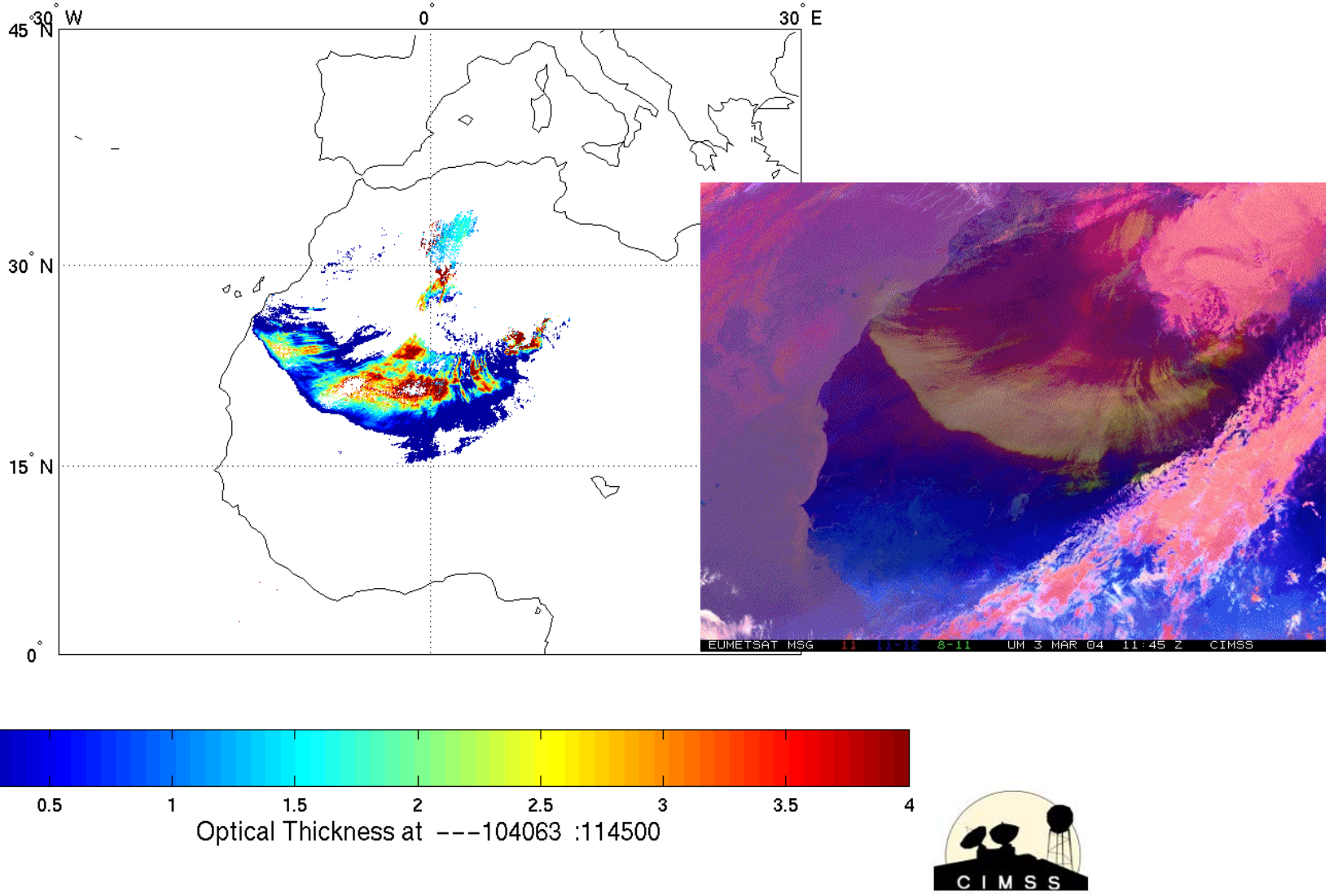


Based on 5-year sample (2005-2009) of Atlantic cases

RGB Air Mass Product



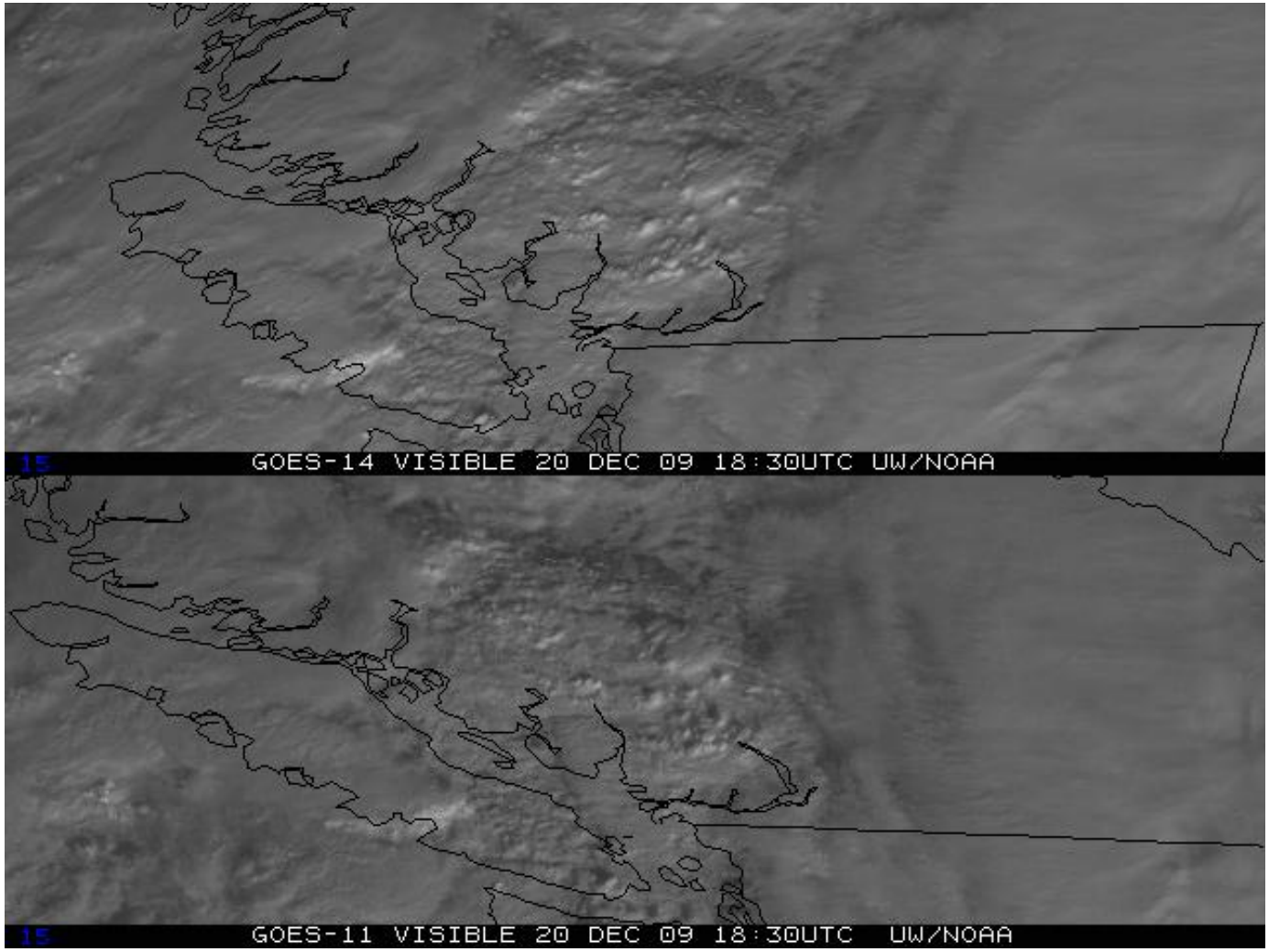
Aerosol/Dust Optical Thickness Retrieval Results from SEVIRI@EUMETSAT



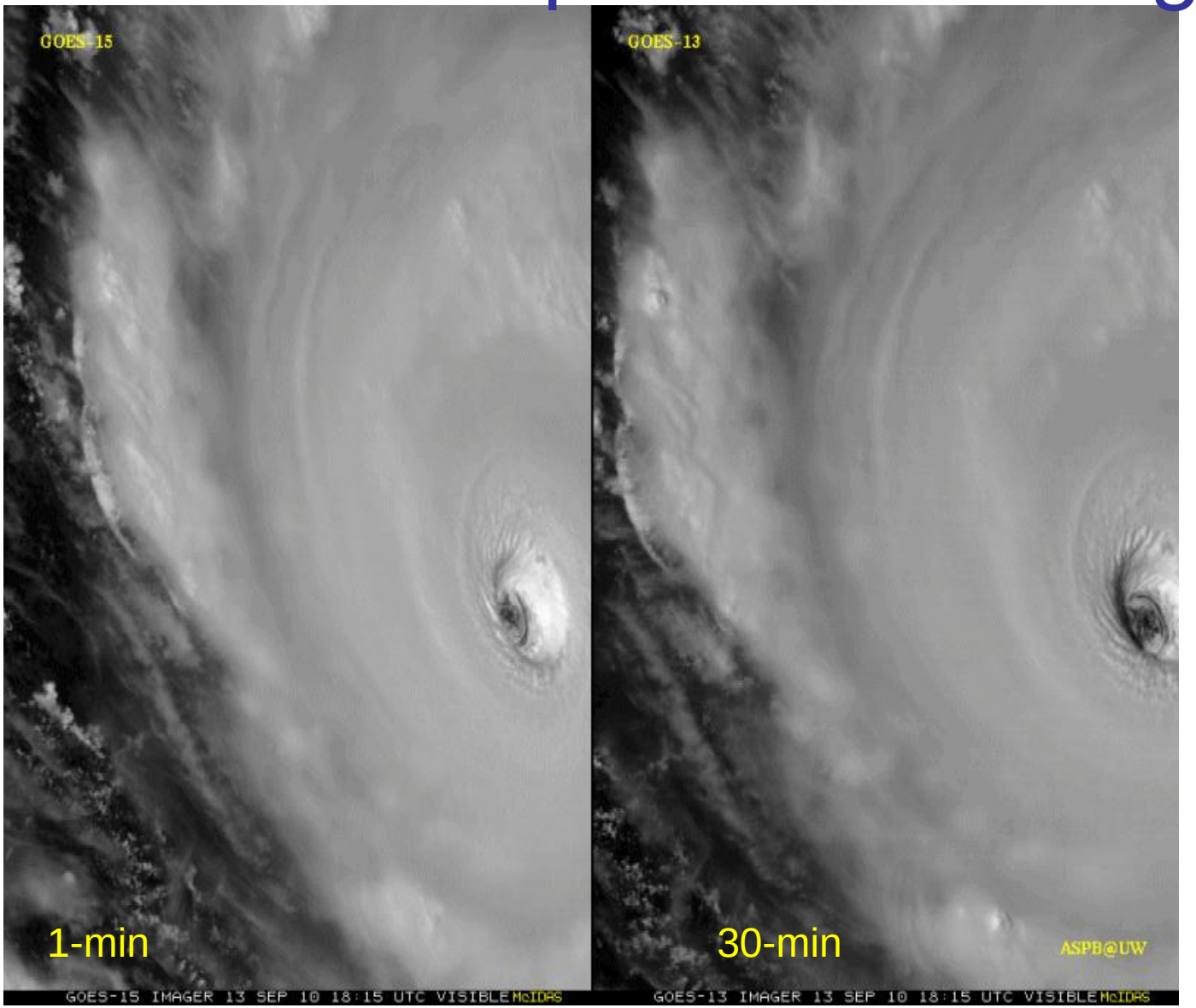
GOES-14: Special “1-min” imagery

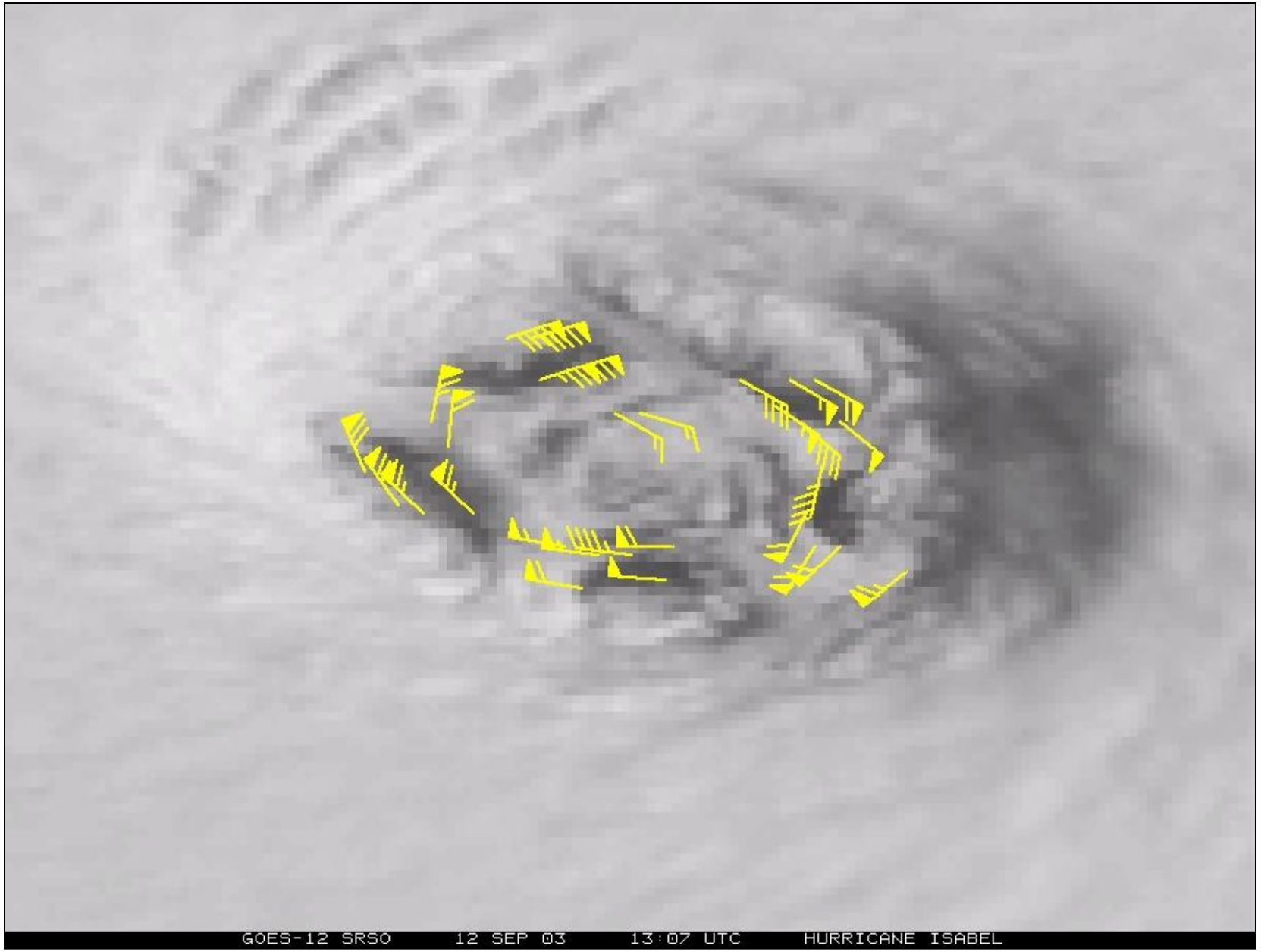
GOES-14

GOES-11



GOES-15: Sample “1-min” imagery

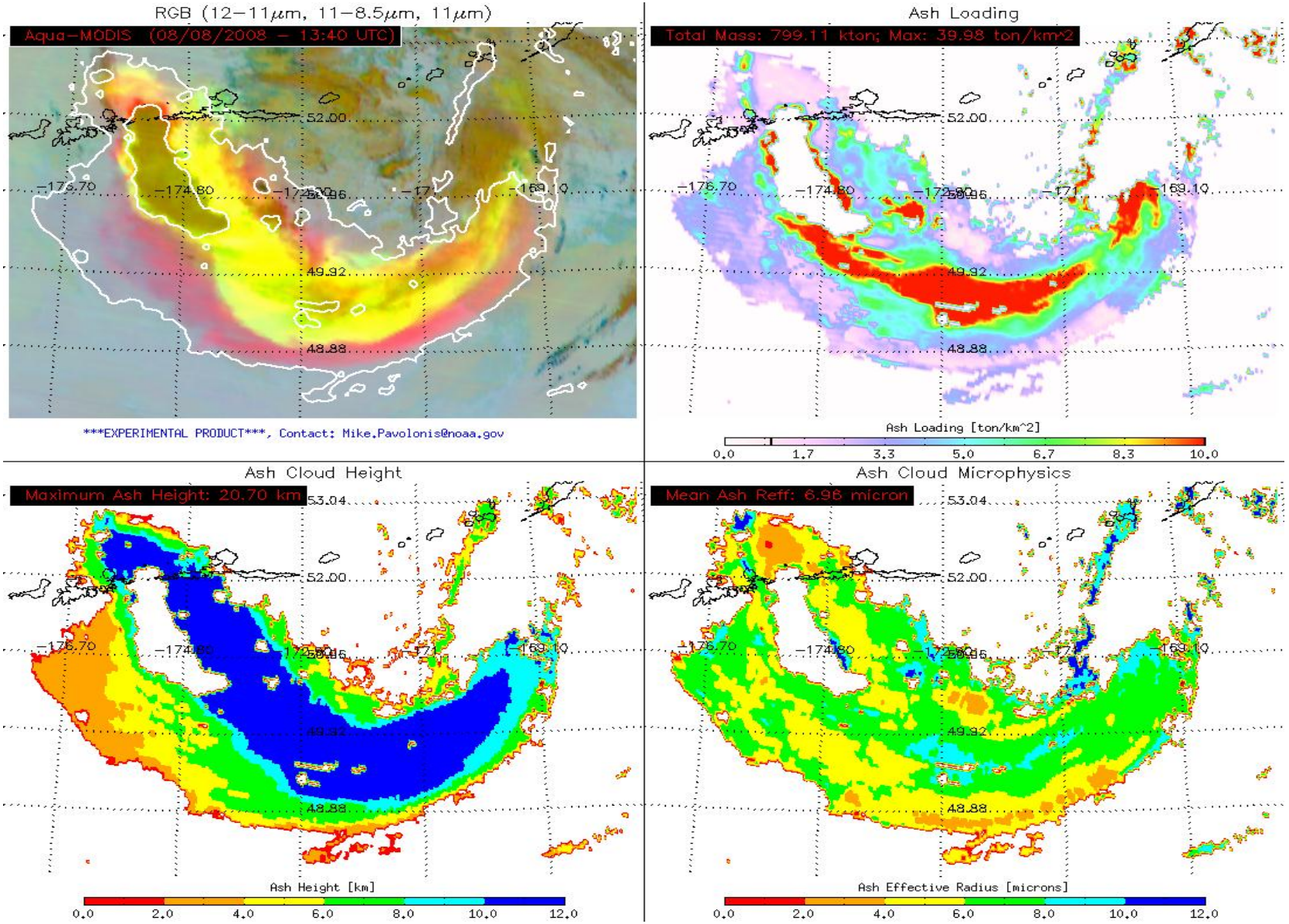


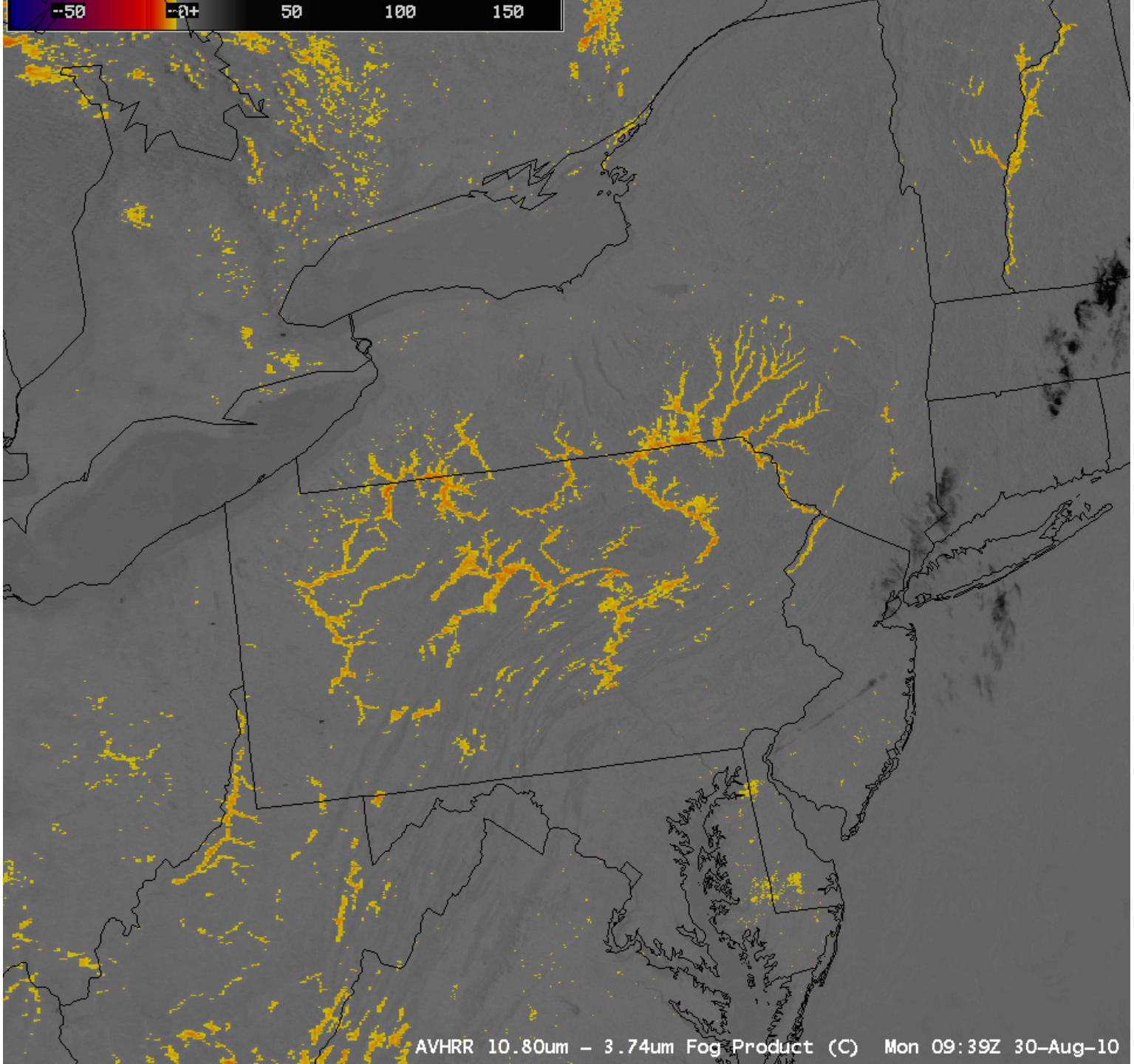


From C. Velden, UW/CIMSS

Rapid scan (3-min) low-level winds in the hurricane eye

Aviation PG Products: Volcanic Ash




-50
-0+
50
100
150
AVHRR 10.80um - 3.74um Fog Product (C) Mon 09:39Z 30-Aug-10

GOES-R Fog Detection

M. Pavolonis

The GOES-R fog detection product will significantly improve geostationary satellite fog monitoring capabilities because:

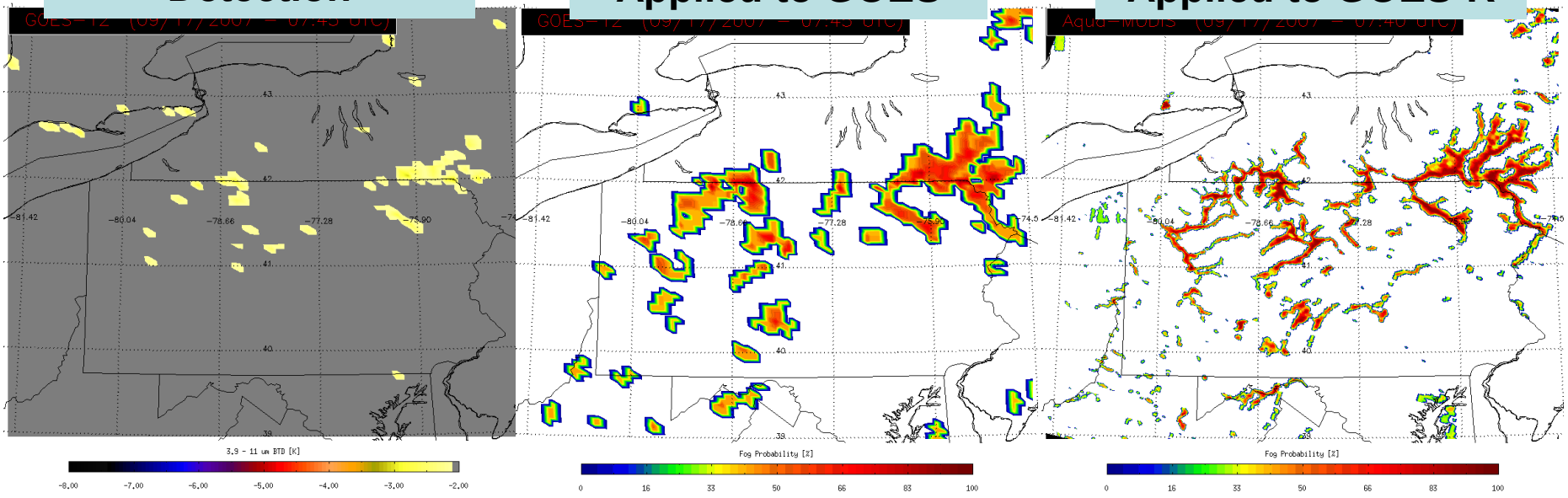
- ***Improved algorithm technology*** - the GOES-R algorithm provides quantitative information on fog probability, while heritage GOES fog detection products are more qualitative in nature

- ***Improved sensor technology*** - the ABI has greatly improved spectral information, spatial resolution, and temporal resolution

Heritage GOES Fog Detection

GOES-R Algorithm Applied to GOES

GOES-R Algorithm Applied to GOES-R



Lessons Learned at SPC (2009)

- Convective Initiation (CI)/Cloud Top Cooling (CTC)
  - CTC is valuable product in itself
  - Diagnostic tool rather than prognostic over SE warm sector environments
  - Masked where thick cirrus present
  - Thin cirrus over land/water/water clouds and expanding edge false alarms
  - Avg. lead time ~15 minutes over radar (for successful nowcasts)
  - Full disk 30 min. scan limitations (false alarms/missed nowcasts)
  - Cloud detection limitations due to poor spatial/spectral resolution
  - Instantaneous fields more useful to forecasters than accumulated fields
  - Overlay on visible/IR essential to forecasters
  - Continue CTC after CI occurs (storm severity) interest from forecasters
  - Effective for terrain/dryline convection
  - CI misses some CTC signals
  - Works well in rapid scan operations

2010 Spring Experiment

Products evaluated and user feedback:

- University of Wisconsin Convective Initiation (USCI)
  - Useful tool for situational awareness prior to warning operations
  - Lead time generally 5-30 min. over radar
  - Forecaster frustration with temporal refresh rate of GOES-13
- Satellite-based convective analysis and tracking (SATCAST)
  - Proxy for the AWG version of the CI algorithm
  - Day-only cloud typing but will be expanded to day and night
  - Data latency an issue (arrived 12-13 post image stamp time)
- Overshooting-top and Thermal Couplet Detection (OTTC)
  - Forecasters liked concept of product but spatial resolution and temporal refresh on GOES-13 provided limited value
- Psedo Geostationary Lightning Mapper (PGLM)
  - Utilizes total lightning data from 3 LMA networks and KSC LDAR
  - Provided strong support tool for warn/ no-warn decision
  - Most viewed future GLM as a “great tool” for situational awareness
  - PGLM particularly useful when blended with other products

2010 Spring Experiment

Products evaluated and user feedback:

- Simulated Satellite Imagery
  - Much enthusiasm for simulated satellite imagery along side traditional model fields
  - Strong push for simulating additional GOES-R channel differences and products as decision aids
  - The simulated imagery can provide more realistic view of GOES-R capabilities in a weather event simulator (WES) case.
- Simulated Lightning Threat
  - Due to time constraints and sub-par performance of the NSSL-WRF…only limited demonstration
  - Expected to provide valuable tool within operations and future experiments includling the 2011 Spring severe weather and summer fire weather experiments.
- 0-3 Hour Severe Hail Probability
  - Product performed well in forecasting severe hail 1-2 hours in advance
  - 3 hour forecast only limited value due to reliance on observations
  - May be most useful in combination with other datasets…such as stability indices

2010 NHC Experiment

Products evaluated and user feedback:

- Hurricane Intensity Estimate (HIE)
  - Generally comparable to ADT, but min SLP can be unrealistically low at times
  - Adjusted applied to HIE pressure estimate
- RGB Air Mass Product
  - Useful complement to the dust product
  - In some ways better separates the dry from moist air masses
  - At times product indicates polar air at very low latitudes
  - There are limb effects that could be corrected as a f(zenith angle)
- SAL Product
  - Animated version: improvement over static images
  - May be contamination near stratocumulus fields
- SRSO data
  - Large number of excellent cases obtained due to GOES-15 science test coinciding with the peak of the hurricane season
- Lightning based RII
  - Post season preliminary results show lightning reduces false alarms of rapid intensity forecasts
  - Additional testing needed to increase sample size

2011 Proving Ground Plans

- Spring Experiment: NWS SPC and Hazardous Weather Testbed
  - Improved version of 2010 products
  - Nearcasting model
- NHC Proving Ground
  - Gain more experience with RGB products
  - Continue evaluation of lightning input
  - Potential new products: Overshooting tops, and product to discriminate thin from thick cirrus over tropical cyclones, true color products
  - Provide RGB products in N-AWIPS format
- Aviation: Alaska Aviation Weather Unit and AWC (Kansas City)
  - Cloud top height and phase (Alaska only)
  - Fog/low cloud probability
  - Volcanic ash mass loading, height, and particle size
  - SO2 detection and loading
  - Convective initiation
  - Nearcasting (AWC only)

2011 Proving Ground Plans

- Marine Weather and Oceanic Testbed: NWS OPC, NHC, NESDIS SAB
  - Cloud and moisture imagery
  - Derived stability Indices
  - Lightning detection
  - Convective initiation
  - Enhanced V / Overshooting top detection
  - Cloud top phase, height, temperature
  - RGB air mass product
- Space Weather PG: U.C. CIRES
  - Solar thematic maps (SUVI)
  - Products from NASA SDO to approximate GOES-R SUVI
  - Create means to ingest and display GOES-R like Level 2+ products

2011 Proving Ground Plans

- NESDIS SAB: Hazardous Weather and Rainfall Potential
  - Cloud and moisture imagery
  - Derived stability Indices
  - Lightning detection
  - Convective initiation
  - Enhanced V / Overshooting top detection
  - Cloud top phase, height, temperature
  - RGB air mass product

- QPF: NWS HPC and NESDIS SAB
  - Cloud and moisture imagery
  - Derived motion winds
  - RGB air mass
  - Rainfall Rate QPE

Summary

- GOES-R Proving Ground provides mechanism to:
  - Involve CIs, AWG, National Centers, NOAA Testbeds and WFOs in user readiness
  - Get prototype GOES-R products in hands of forecasters
  - Keep lines of communication open between developers and forecasters
  - Allow end user to have have say in final product, how it is displayed and integrated into operations
- Proving Ground continues to grow and plans in place for 2011
- For a GOES-R Success…Forecasters must be able to use GOES-R products on Day 1

7th GOES Users Conference

Joint with 36th Annual NWA Meeting in Birmingham, AL

Oct. 15-21, 2011 at the Wynfrey Hotel

Visit: http://www.goes-r.gov or http://www.nwas.org/meetings for more info!

Backup Slides

Using the GOES-12 Sounder to Nearcast Severe Weather

Robert Aune (NESDIS) and Ralph Petersen (CIMSS)

The CIMSS Near-casting Model uses hourly GOES Sounder retrievals of layered precipitable water (PW) and equivalent potential temperature (Theta-E) to predict severe weather outbreaks up to *6 hours in advance!*

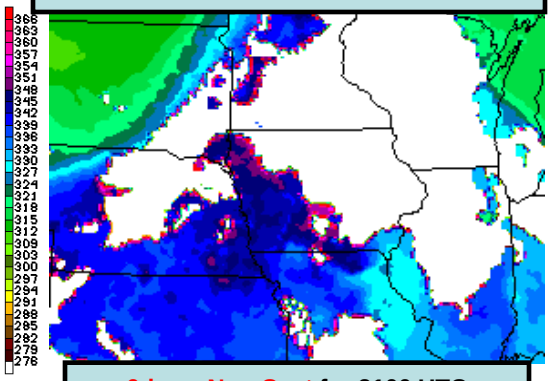
Hourly, multi-layered observations from the GOES Sounder are projected forward in time along Lagrangian trajectories forced by gradient winds. "Trajectory observations" from the previous six hours are retained in the analysis. Destabilization is indicated when theta-E decreases with height.

Limitations:

- **Sounder channels support only two layers for near-casting**
- **Only useful for elevated convection – Sounder can't detect low-level moisture**
- **Frequent false alarms – Sounder can't detect inversions**

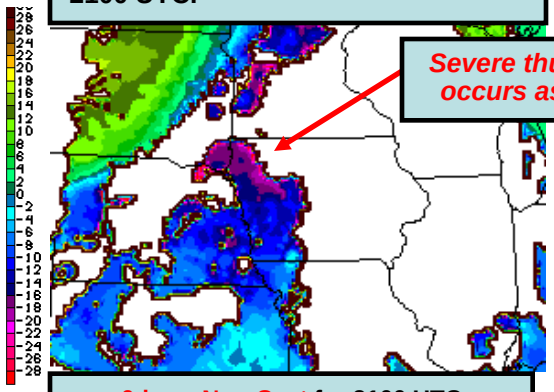
One Example of a Successful Near-cast

Low-level Theta-E NearCasts shows warm moist air band moving into far NW Iowa by 2100 UTC.



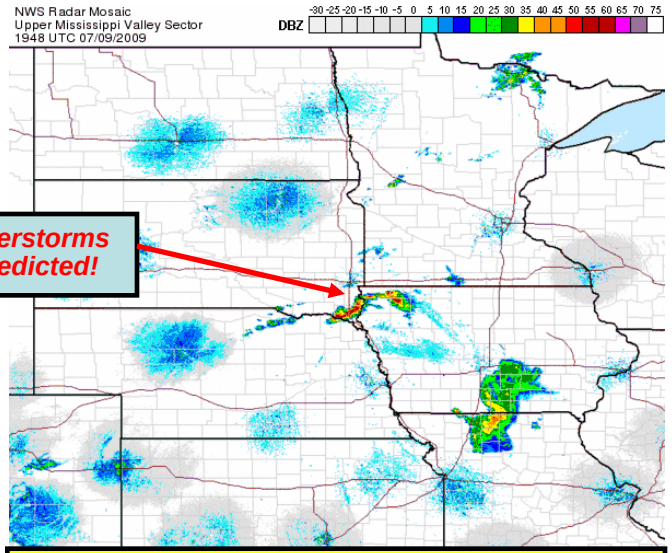
6-hour NearCast for 2100 UTC
Low level Theta-E

Vertical Theta-E Differences predict complete convective instability by 2100 UTC.



6-hour NearCast for 2100 UTC
Low to Mid level Theta-E Differences

Severe thunderstorms occurs as predicted!



Rapid Development of Convection over NW Iowa between 2000 and 2100 UTC 9 July 2009

Proving Ground Organization

Executive Board:
Steve Goodman (Chair)- NESDIS/GOES-R Senior Program Scientist
Jaime Daniels-NESDIS/STAR/GOES-R AWG
Mark DeMaria-NESDIS/STAR/ GOES-R Risk Reduction
Jim Gurka- NESDIS/GOES-R Ground Segment Project Scientist
Mike W. Johnson, NWS/OST/Programs & Planning
Tim Schmit-NESDIS/STAR/ASPB
Kevin Schrab- NWS
Gary Jedlovec-NASA SPoRT

Advisory Team:
Tony Mostek-NWS/COMET
Russ Schneider- NWS/NCEP/SPC
Gary Hufford- NWS Alaska Region
Shanna Pitter- PPI, NWS WW Goal Team
Cecilia Miner- NWS, C&T Goal Team
Steve Miller- CIRA
Wayne Feltz-CIMSS
Shobha Kondragunta-NESDIS/STAR AQ IPT